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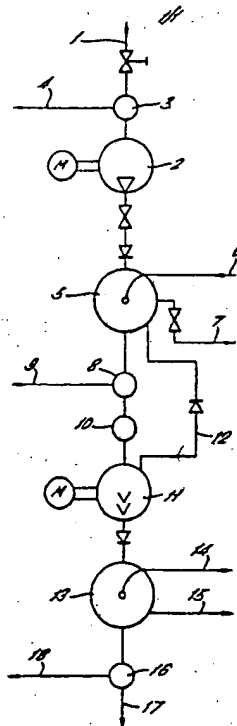
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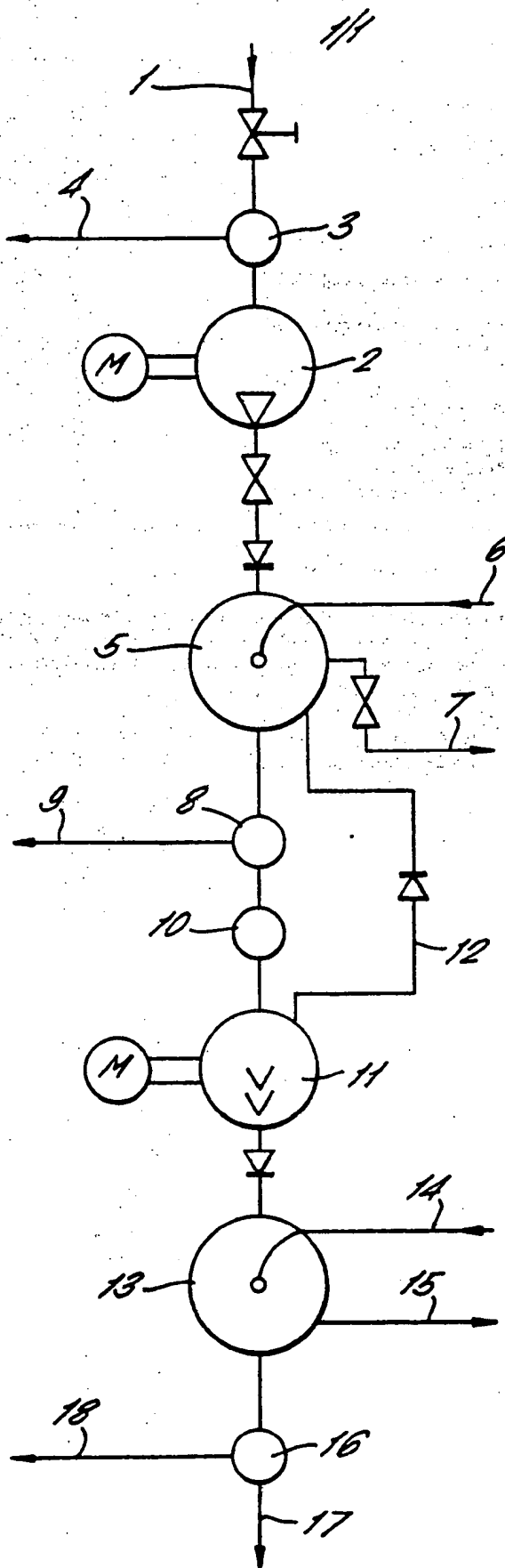
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## (54) Treatment of gas from a landfill site

- (57) A process for the treatment of gas from a landfill site, which process comprises the steps of
- (i) extracting the gas from the landfill site under negative pressure (from pump 2);
  - (ii) passing the gas through a first water trap 3 to remove droplets of entrained liquid therefrom;
  - (iii) passing the gas through a first scrubber 5;
  - (iv) compressing the gas (11);
  - (v) passing the gas through a second scrubber 13; and
  - (vi) passing the so-treated gas through a second water trap 16 to remove moisture droplets therefrom.



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A PROCESS AND APPARATUS FOR THE TREATMENT OF  
GAS FROM A LANDFILL SITE

5       The present invention relates to a process  
and apparatus for the treatment of gas from a  
landfill site and, in particular, to a process and  
apparatus for treating gas from a landfill site to  
make it suitable for burning in an internal  
combustion engine.

10       Domestic refuse is often used to fill sites  
from which natural resources, such as gravel, stone  
and sand etc., have been removed. These sites are  
generally called landfill sites and when the site has  
been filled it is generally grassed over so that it  
15       once more becomes a part of the countryside. The  
refuse in the landfill site produces a gas as a  
result of decomposition, digestion or interaction of  
the components of the refuse. This landfill gas  
contains a fairly high concentration of methane,  
20       typically of the order of 40-60% by volume and it  
causes nuisance and possibly danger, so precautions  
often have to be taken, for example by drawing the  
gas and flaring it.

25       The landfill gas can be used in several ways,  
e.g. as a process fuel in boilers or brick-kilns or  
as a fuel in internal combustion engines for example  
to drive alternators to generate electricity.

30       Experience in the United States of America  
and Germany has demonstrated that severe damage can  
be caused to internal combustion engines which are  
fed gas directly from a landfill site without prior  
treatment. In view of the losses that would occur,  
both in terms of damage to the equipment and loss of  
production, in the event of a failure resulting from  
35       the internal combustion engine being fed untreated  
gas, it would be desirable to provide a simple and

efficient system for the treatment of the landfill gas to render it suitable for burning in an internal combustion engine. One problem which is associated with landfill gas is that when the gas is withdrawn  
5 under negative pressure from the landfill site it is generally at a temperature of about 40°C and entraps particles of debris, droplets of moisture and droplets of leachate which may be acid.

It has previously been proposed in  
10 EP-A-0180670 to scrub biogas to remove carbon dioxide therefrom using two scrubbers arranged in series. The spray scrubbers atomise a carbon dioxide absorbent liquid which is regenerated and returned to the scrubbers. The absorbent liquid is preferably  
15 water which is fed under pressure to a regeneration unit where the water is atomised and its pressure dropped to ambient, so forcing out carbon dioxide dissolved therein. This specification does not address the problem of removing particles of debris  
20 and droplets of leachate from the gas, prior to scrubbing.

We have now developed a process and apparatus for the treatment of gas from a landfill site which renders the gas suitable for burning in an internal  
25 combustion engine in order to produce electricity.

Accordingly, the present invention provides a process for the treatment of gas from a landfill site, which process comprises the steps of

- 30 (i) extracting the gas from the landfill site under negative pressure;
- (ii) passing the gas through a first water trap to remove droplets of entrained liquid therefrom;
- (iii) passing the gas through a first scrubber;
- 35 (iv) compressing the gas;
- (v) passing the gas through a second

scrubber; and

(vi) passing the so-treated gas through a second water trap to remove moisture droplets therefrom.

5 In an alternative aspect the present invention provides apparatus for the treatment of gas from a landfill site, which apparatus comprises means to extract the gas under pressure from the landfill site;

10 a first water trap to remove droplets of liquid entrained in the gas;

a first scrubber;

means to compress the gas;

a second scrubber; and

15 a second water trap to remove droplets of water entrained in the gas.

In carrying out the process of the present invention, the gases preferably extracted from the landfill site at a negative pressure of up to 60  
20 inches water gauge. This may be achieved by use of a pump, such as a field suction pump. The gas from the landfill site is passed through first water trap which is a bed of a sieve material in order to remove droplets of leachate and moisture from the gas, and  
25 also to remove particles of debris therefrom. The gas is then passed to a first scrubber, preferably a countercurrent scrubber in which water is used as the scrubbing medium. This scrubbing step completes the removal of liquid leachate droplets, particles of  
30 debris and some corrosive gases from the landfill gas.

The gas is then compressed to a pressure preferably in the range of from 30 to 60 psig. This compression may be achieved, for example, by using a double acting reciprocating compressor.

35 The gas is then washed in a second scrubber. Preferably the gases are scrubbed in a countercurrent

scrubber using water as the scrubbing medium. This second scrubbing stage removes carbon dioxide from the landfill gas and thus serves to enrich the methane content of the landfill gas. The levels of other contaminants in the gas are also reduced during this scrubbing stage. The gas is then passed to a second water trap which is preferably a sieve material. This sieve material removes water droplets from the gas.

10       The gas, after the treatment as described above, may be burned in an internal combustion engine driving an alternator in order to generate electricity. The treated gas will generally leave the treatment apparatus at a pressure of up to 15 psig and it can be fed into the internal combustion engine at this pressure without any further treatment being required.

20       The process and apparatus of the invention are described in more detail with reference to the accompanying drawing which is a schematic diagram of the gas treatment apparatus of the invention.

Referring to this drawing, landfill gas is withdrawn from a landfill site (not shown) along line 1 under pressure which is applied to the gas by a field suction pump 2. The gas passes through a first water trap 3 which comprises an eighteen inch bed of a sieve material sold under the name Knitmesh. The moisture and leachate removed by the water trap exits along line 4. The gas is then passed to the bottom of a countercurrent scrubber 5. At the point of entry into the scrubber the gas is at a pressure of approximately 20 inches water gauge. Water as the scrubbing liquid passes to the top of the countercurrent scrubber and the scrubbing liquid then exits along line 7. The scrubbing liquid may be kept in an appropriate tank (not shown). In scrubber 5,

remaining traces of leachate, organic debris and corrosive trace gases are removed from the landfill gas.

5       The gas leaving the scrubber 5 is passed via  
an intermediate water trap which is an optional  
feature of the invention. This water trap removes  
water droplets from the gas stream and the moisture  
is removed along line 9. The gas is then passed  
10       through a pressure regulator 10. The landfill gas  
will preferably be at a pressure of 5 inches water  
gauge before it is passed to the compressor 11 for  
compression to a pressure in the range of from 30 to  
60 psig. Line 12 is an unloader line whereby excess  
pressure produced by the compressor is relieved by  
15       passing some of the landfill gas back to the bottom  
of scrubber 5. The gas leaving compressor 11 is  
passed to the bottom of a second countercurrent  
scrubber 13. Water is introduced as scrubbing liquid  
along line 14 to the top of the scrubber and the  
20       scrubbing liquid leaves via line 15. The scrubbing  
liquid may be stored in an appropriate tank which is  
not shown. After the final scrubbing of the landfill  
gas in scrubber 13, the gas is then passed to water  
trap 16 which is the second of the traps essential to  
25       the operation of the invention. This trap comprises  
a fourteen inch bed of a sieve material sold under  
the name Knitmesh. The landfill gas exits from the  
water trap along line 17 and the moisture removed by  
the water trap exits along line 18.

30       The landfill gas exiting along line 17 is  
suitable to be burnt without further treatment in an  
internal combustion engine attached to an alternator  
for the generation of electricity.

35       One important advantage of the process and  
apparatus of the invention is that it is adapted to  
treat any gas which leaves a landfill site. It will

be appreciated in this context that the composition of a landfill gas will also vary not only from landfill site to landfill site but will vary in its composition during the lifetime in which the site is producing landfill gas. This is because at the beginning of the decomposition and digestion processes the gases which are given off are very different from the gases which are produced from the same site after a period of time.

10           The process of the invention produces a treated landfill gas which is not corrosive to internal combustion engines and which contains a sufficiently high content of methane to be burnt in internal combustion engines without additional  
15           treatment being required.

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CLAIMS

1. A process for the treatment of gas from a landfill site, which process comprises the steps of
  - (i) extracting the gas from the landfill site under negative pressure;
  - (ii) passing the gas through a first water trap to remove droplets of entrained liquid therefrom;
  - (iii) passing the gas through a first scrubber;
  - (iv) compressing the gas;
  - (v) passing the gas through a second scrubber; and
  - (vi) passing the so-treated gas through a second water trap to remove moisture droplets therefrom.
2. A process as claimed in claim 1 wherein the gas is extracted from the landfill site at a negative pressure of up to 60 inches water gauge.
3. A process as claimed in claim 1 or claim 2 wherein the gas is passed in step (ii) through a water trap which comprises a sieve material.
4. A process as claimed in any one of the preceding claims wherein the gas is scrubbed in step (iii) countercurrently using water as the scrubbing medium.
5. A process as claimed in any one of the preceding claims wherein the gas is compressed in step (iv) to a pressure in the range of from 30 to 60 psig.

6. A process as claimed in any one of the preceding claims wherein the gas is scrubbed in step (v) countercurrently using water as the scrubbing medium.

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7. A process as claimed in any one of the preceding claims wherein the gas is passed in step (vi) through a water trap which comprises a sieve material.

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8. Apparatus for the treatment of gas from a landfill site, which apparatus comprises means to extract the gas under pressure from the landfill site;

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a first water trap to remove droplets of liquid entrained in the gas;

a first scrubber;

means to compress the gas;

a second scrubber; and

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a second water trap to remove droplets of water entrained in the gas.

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9. Apparatus as claimed in claim 8 wherein the means to extract the gas under pressure from the landfill site comprises a suction pump.

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10. Apparatus as claimed in claim 8 or claim 9 wherein the first and second water traps comprise a sieve material.

11. Apparatus as claimed in any one of claims 8 to 10 wherein the first and second scrubbers are countercurrent scrubbers.

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12. Apparatus as claimed in any one of claims 8 to 11 wherein the gas is compressed using a

compressor.

13. Apparatus as claimed in claim 8  
substantially as hereinbefore described with  
5 reference to and as illustrated in the single Figure  
of the drawings.

14. Landfill gas which has been treated by a  
process as claimed in any one of claims 1 to 7.  
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15. A method for the generation of  
electricity which method comprises burning a landfill  
gas as claimed in claim 14 in a internal combustion  
engine attached to an alternator.  
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